



Clinical Aspects of Traumatic Brain Injury (TBI)

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Outline



- Classification and measuring TBI
- Mechanisms of damage from TBI
- TBI sequelae and Post-Concussion Syndrome
- Mild TBI and Behavioral Health

Classification of TBI



Mechanism

Closed head trauma vs. penetrating head trauma



Structural abnormalities

Mass lesion (e.g. hematoma)
Diffuse axonal injury
Brain swelling

Clinical severity

Glasgow Coma Scale
Level of consciousness
Post-traumatic amnesia



MILD

MODERATE

SEVERE

Measuring TBI



Grades of TBI

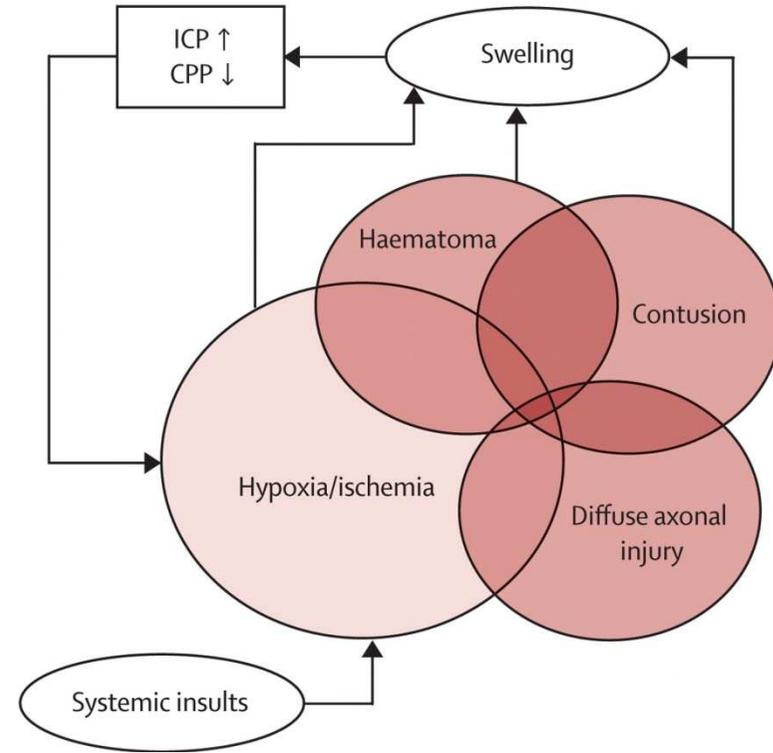
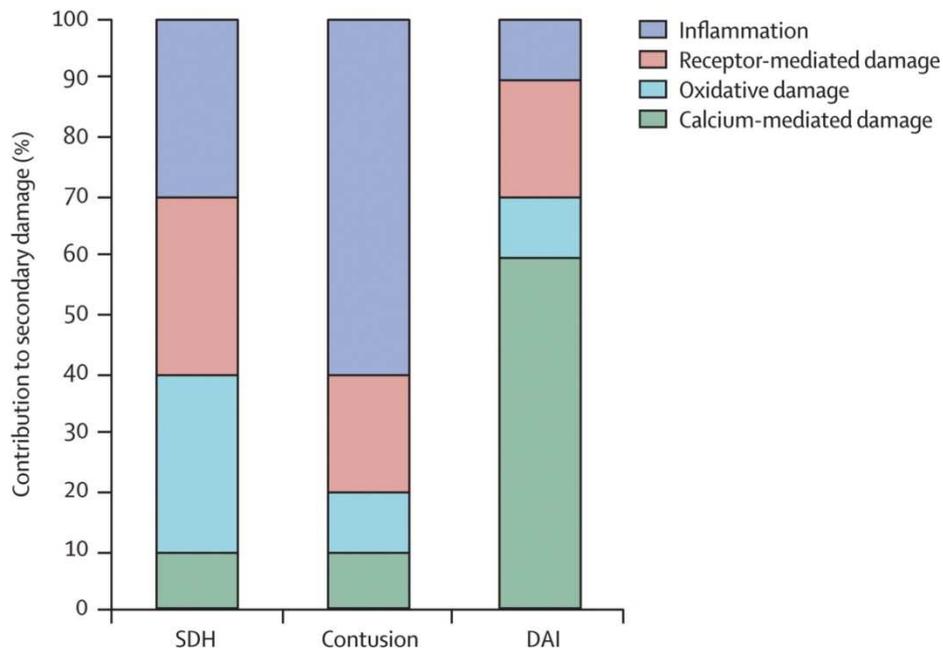
Mild (Grade 1) “concussion”	Moderate (Grade 2)	Severe (Grade 3 & 4)
Altered consciousness < 30 minutes “Normal” CT/MRI	Altered consciousness < 6 hours Abnormal CT/MRI	Altered consciousness > 6 hours Abnormal CT/MRI
Glasgow Coma Scale 13 - 15	Glasgow Coma Scale 9 - 12	Glasgow Coma Scale < 9
Post-traumatic amnesia < 24 hours	Post-traumatic amnesia < 7 days	Post-traumatic amnesia > 7 days



75%

25%

The Mechanisms of Damage from TBI



ICP= Intracranial pressure

CPP= Cerebral perfusion pressure

Blast Injury

Blast Injuries – 4 types

*Primary – Overpressure of “blast wave” – ear, lung, GI

Secondary – flying debris

Tertiary – thrown into stationary objects or structural collapse

Quaternary – Any injury due to other mechanisms - e.g. thermal, burns, toxic inhalation, etc.

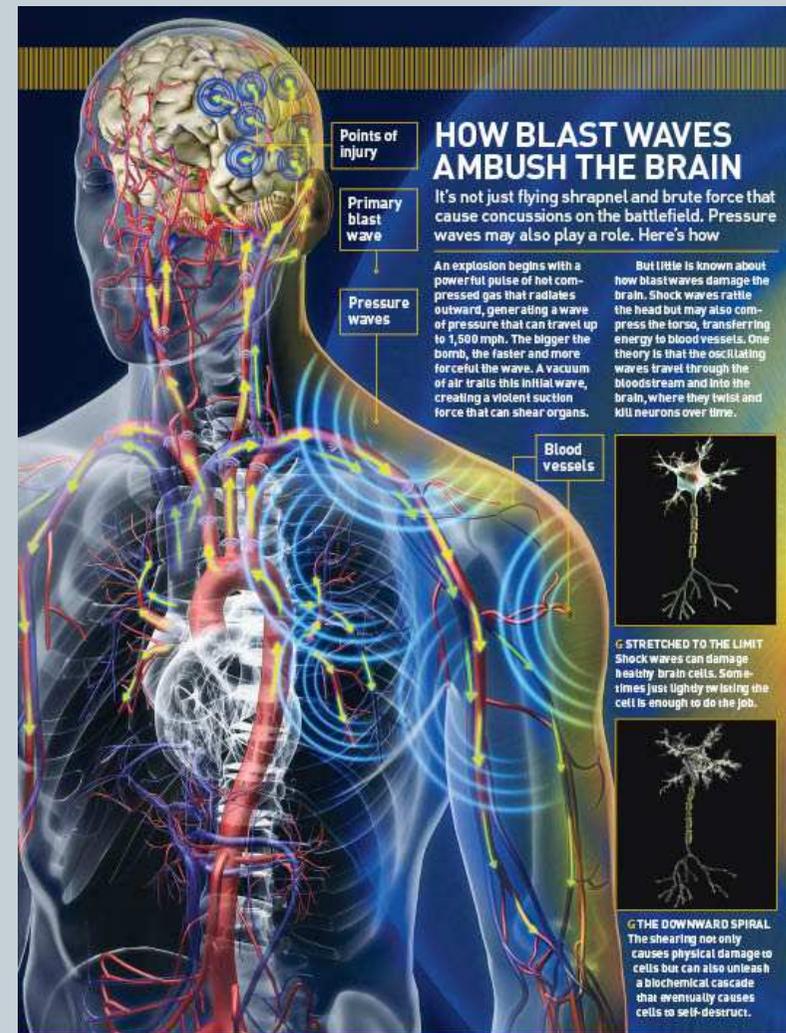


Blast wave

- High pressure shock wave
- Blast wind

Blast-Related TBI

- Mechanism of Injury
 - Acceleration of the head
 - Transmission of pressure waves across skull
 - Propagation of waves via thoracic mechanism
- Cernak (*J Trauma*, 1999)
 - Blast waves ripple through thorax via blood vessels
 - Oscillations of vessels are transmitted to the brain causing damage to adjacent neurons



Primary Blast Injury: A Case Report of SGT B

- 50 y/o SGT in Iraq walking back to quarters
 - Explosion hit the ammo area of their own base
 - Sgt B – crouched behind a five inch thick cement bunker with vest and helmet
 - Exposure to three hours of explosions – 10/2006
 - Three episodes of “having her bell rung” concurrent with “chest hurt” – once when she peered outside as a new explosion occurred
 - Did not fall or hit her head at any point
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- Immediate aftermath –
 - Two weeks of headache, dizziness, balance problems, nausea/vomiting – treated initially for dehydration d/t vomiting; also insomnia, anxiety, nightmares
 - Gradually felt better, remained at admin position



Neurological Impairments in Moderate/Severe TBI at 1 month

Deficit	Percentage (%)
Cognitive disability	60-90
Paralysis/Weakness	60
Slurred speech	50
Cranial Neuropathy	30
Swallowing problem	30
Lack of coordination	10
Visual deficits	6



www.healthline.com

Treatment Issues - Cognition

- Attention
- Perception
 - Auditory
 - Visuospatial
- Memory
 - Visual learning
 - Verbal learning
- Executive Function
 - Planning
 - Initiation
 - Hypothesis testing
 - Self-regulation
- Intelligence
- Language

Cognitive pharmacology

- Avoid phenytoin
- **Attention** and **speed of processing**
 - Methylphenidate and donepezil
 - *option* - D-amphetamine; amantadine
- **Memory** deficits
 - Donepezil
 - *option* - methylphenidate
- **Executive function**
 - Bromocriptine?
- Methylphenidate and amantadine recommended for general cognitive deficits

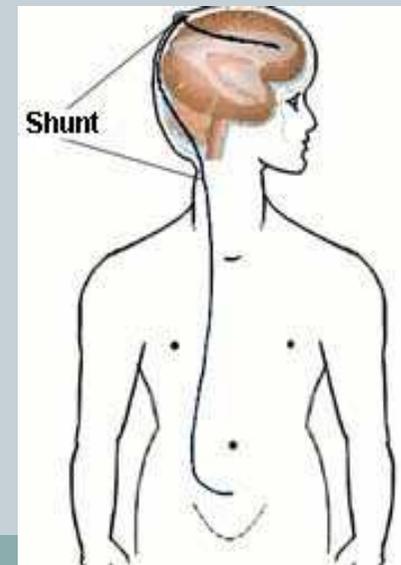
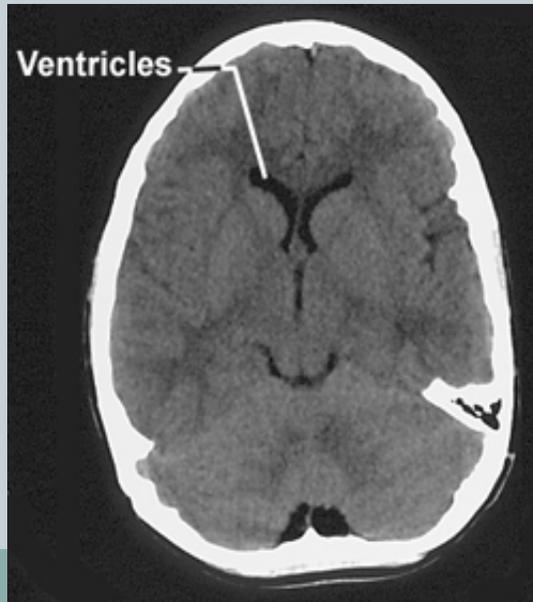
Treatment Issues - Behavior

- Disinhibition
 - Impulsiveness
 - Aggressiveness
 - Irritability
 - Lability; Euphoria
 - Paranoia
 - Sexual Deviation
 - Passive; Indifference
- Improvement tends not to occur after 2 years
 - Treatments
 - No established drug treatment for affective disorders, anxiety, or psychosis
 - Behavioral modification
 - Psychotherapy

Hydrocephalus



- Found in 2/3 of patients with mod/severe TBI
- Associated with worse outcome
- Treatment with CSF shunting can improve function



Diagnosis of Mild TBI



- Obligatory criteria
 - **A credible mechanism of injury***
 - **Craniofacial impact***
- Major criteria
 - **Amnesia for blow***
 - **Disordered awareness* not necessarily with LOC**
 - **Finite PTA***
 - GCS score <15
 - Impact seizure
 - Initial vomiting with headache
 - Binocular diplopia
 - Central vertigo
 - Focal CNS or cranial nerve signs
 - Clinical signs of basilar skull fracture
- Non-specific criteria
 - Perception of being dazed at time of injury
 - Headache, dizziness, blurred vision, tinnitus, photo- and phonophobia, fatigue, disordered sleep
 - Cognitive-behavioral symptoms
 - Neuropsychological test findings.

*Minimum criteria for retrospective diagnosis

ACRM/VA Definition of TBI



- Traumatically-induced physiological disruption of brain function as demonstrated after an event by at least one of the following:
 - (1) any period of loss of consciousness
 - (2) any loss of memory for events immediately before or after the event;
 - (3) any alteration in mental state at the time of the event, for example feeling dazed, disoriented, or confused
 - (4) a focal neurological deficit or deficits that may or may not have been transient, for example loss of coordination, speech difficulties, or double vision.

Post-Concussion Syndrome (PCS)



- Post-concussion syndrome is a set of symptoms that may follow a mild TBI:

Poor concentration
Memory difficulty
Intellectual impairment
Irritability
Fatigue

Headache
Anxiety/depression
Dizziness
Blurred vision
Light/sound sensitivity

- May appear up to 2 weeks post TBI
- Most patients with PCS make a complete recovery in 3 months
- Chronic problems in 15-20%; may persist ≥ 1 year

Post Concussion Syndrome (PCS)



- PCS – “neurogenic” vs. “psychogenic”
 - Brain imaging, EEG, etc. abnormalities are non-specific
 - PCS symptoms are seen in somatization disorders, depression, or PTSD
 - Cultural differences; litigation
- Limited studies examining interaction of TBI and anxiety/depression or PTSD.

PTSD symptoms

Flashbacks
Recurrent experiences
Easily startled

PTSD & PCS symptoms

Poor concentration
Depression
Irritability
Memory problems

PCS symptoms

Headache
Nausea/emesis
Dizziness/Vertigo
Diplopia

Mild Traumatic Brain Injury in U.S. Soldiers Returning from Iraq

Charles W. Hoge, M.D., Dennis McGurk, Ph.D., Jeffrey L. Thomas, Ph.D., et al N Eng J Med 2008;358:453-63



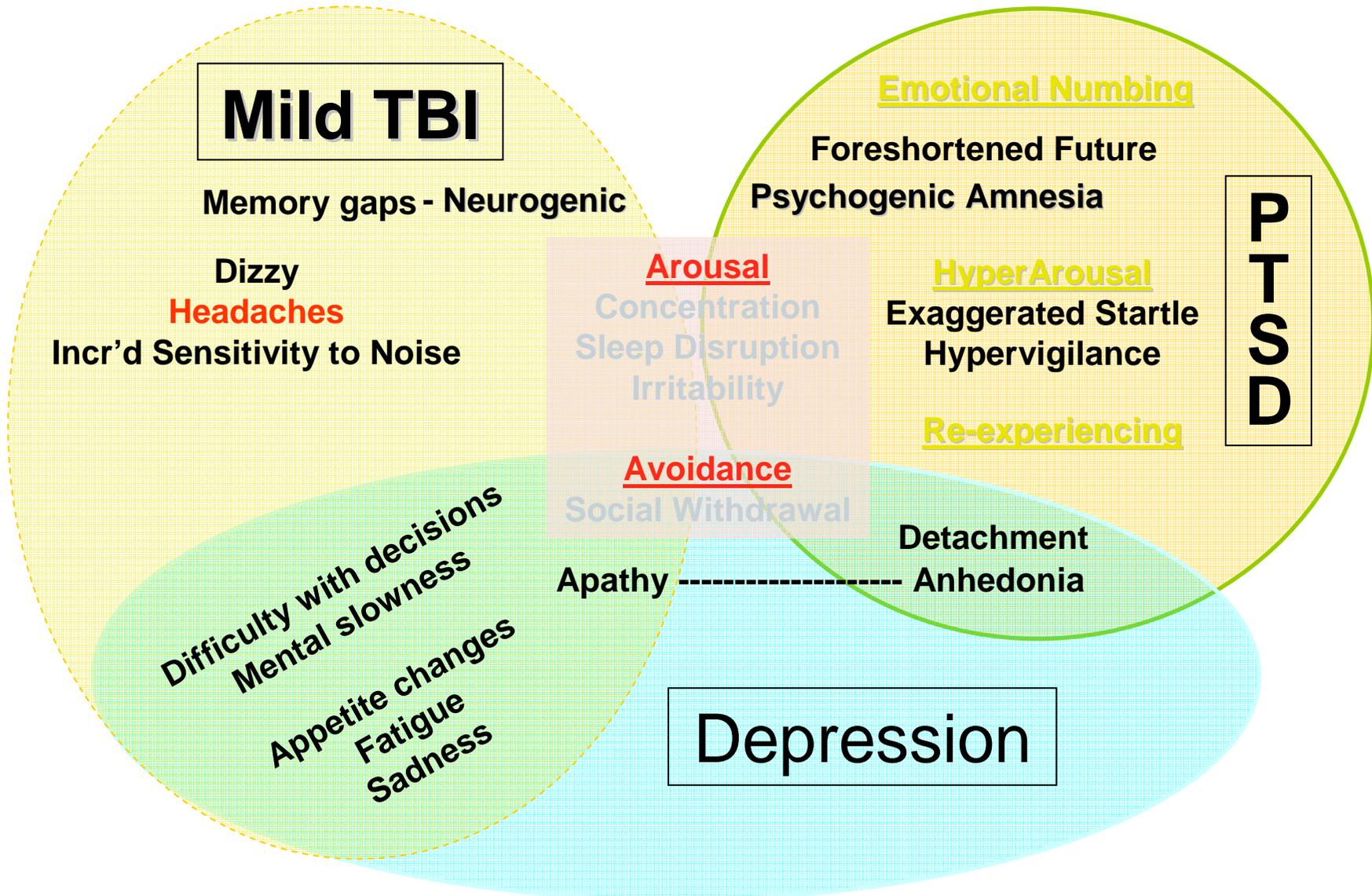
- 2525 Iraq vets –
 - 15% reported injuries c/w mild TBI
 - 1/3 of mild TBIs reported loss of consciousness (LOC)
- 44% of vets with LOC met criteria for PTSD
- Mild TBI was associated
 - poor health
 - high somatic and post concussive symptoms
- When adjusted for depression and PTSD – **headache** was the only significant association with TBI

Mild TBI - Headache



- Common - 25 to 78% of TBI
- Prevalence and duration is greater in mild vs. severe TBI
- In 126 OEF/OIF vets identified by the VA TBI screen and confirmed mild TBI (Ruff et al. *J Reh Res Dev*, 2008)
 - Headaches were more likely to be seen in those with neurocognitive deficits from TBI (93% v 13%)
 - mTBI vets with neurocognitive deficits experienced a greater # of blasts and ≥ 1 episode of LOC
 - Headaches were more likely to have features of migraine
 - ✦ Intense, pulsating, unilateral, GI symptoms;
 - ✦ Sensitivity to light, sound, activity
 - These vets were also more likely to have PTSD and sleep disturbance
- No difference in headaches after mild TBI vs post-orthopedic injury (Stovner et al, *Eur Neurol*, 2007)

Revised TBI-PTSD Presentations



Summary



- TBIs damage the nervous system via multiple mechanisms - blast exposure may be unique
- Most TBIs during the OEF/OIF conflicts are mild TBIs and have been associated with blasts
- Cognitive-behavioral symptoms are common in TBIs of all severities. Treatments are limited.
- The distinction between PCS and other behavioral health problems is unclear
- Better understanding of mTBI will require better methods of diagnosis